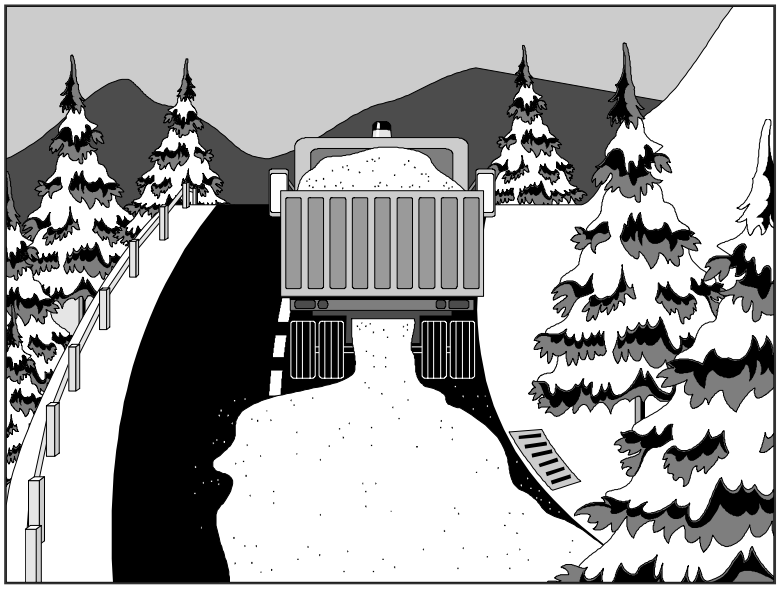
Traction Sand Trap Devices



BMP Objectives

- ● Sediment
- ○ Oil and Grease
- ○ Metals and Toxics
- ○ Nutrients
- ○ Bacteria and Viruses

- ● Highly Effective
- ○ Low Effectiveness

Definition and Purpose

A traction sand trap is a device that allows traction sand to settle out of highway storm water runoff. It must provide sufficient storage volume to retain the settled sand until the traction sand trap is cleaned. A traction sand trap is a permanent control measure that may be a stand-alone device, or may be incorporated as part of another storm water facility such as a detention basin.

Caltrans routinely applies sand on snowy or icy roadways, primarily in mountainous areas, to provide additional traction for vehicles. The main purpose of sand traps is to recapture this sand from storm water runoff, thereby reducing traction sand discharges to receiving waters and habitats. Traction sand traps are not efficient at removing fine sediments (silts, clays) or other pollutants and should not be considered for this purpose.

Typically, a traction sand trap device is a drainage inlet that has been modified to capture and retain traction sand. Typical modifications include increasing the depth of the inlet so that there is a settling/storage area below the invert of the outlet pipe, linking multiple inlets for increased storage volume, and adding weep holes to allow the storage volume to drain.

Appropriate Applications

Consider traction sand trap devices for roadways in the following locations where sand is applied for traction control:

- The Lake Tahoe and Truckee River hydrologic units in District 3.
- Elevations above 7,000 ft in the Mammoth Creek Hydrologic Unit in District 9.
- The Carson River East Fork and West Fork hydrologic units in District 10.

Limitations

Traction sand trap devices:

- Have a tributary area limited to that of a single inlet location.
- Provide relatively little traction sand storage volume.
- May result in traction sand discharges during high flow conditions as a result of limited volume, turbulent conditions, or insufficient settling time.
- Are difficult to design for a particular removal efficiency.
- Require the use of a vacuum truck for cleaning.

Design Guidance

Volume for Sand Storage.

The volume required to store traction sand is calculated by starting with the estimated amount of traction sand spread in a given area and applying reduction factors to account for sand that has been recovered by other means or that cannot be captured. The equation is:

$$V = (S \times R \times L \times E)/F$$

Where:

V = The total volume of traction sand that must be stored (m^3).

S = The estimated volume of sand applied (m^3/yr).

R = a reduction factor to account for sand recovered by roadway sweeping.

L = A factor to account for other miscellaneous losses/accumulations.

E = An estimated recovery efficiency.

F = The number of times the trap will be cleaned (times/yr.) (see below)

S: Typical sand application rates range from 47 m^3/lane/km/yr for areas with average application rates to 95 m^3/lane/km/yr for areas with high application rates. To estimate the total volume of traction sand applied, select an appropriate application rate from the range listed above, and multiply it by the total number of lanes (e.g., one lane in each direction equals two lanes) and the length of highway tributary to the sand trap. Because some areas track sand usage by post mile, a more accurate estimate may be obtained by consulting with District maintenance staff. In any event, consider the following guidelines when estimating the volume of sand that is spread annually in the tributary area:

Exposure: Roadways on north facing slopes generally require more traction sand than similar south facing slopes. The surrounding vegetation may also significantly affect exposure and traction sand application.

Roadway grade: steeper grades generally receive more traction sand.

Other climatic and geographic factors, such as elevation, will affect the traction sand application rate for a specific area.

Other sources of similar material: Adjacent cut slopes and other non-paved tributary areas may contribute similar-sized sediment or other debris that will be retained in the trap.

R: This is a reduction factor to account for traction sand that is recovered through roadway sweeping. Estimate a value between 1.0 (no roadway sweeping) and 0.6 (aggressive winter roadway sweeping) based on interviews with District maintenance staff. If actual sweeping records are available, these may provide a more accurate estimate.

L: This is a factor to account for traction sand that has been carried into or out of the tributary area by miscellaneous means such as wind (smaller particles), sand thrown out of the tributary area by snow clearing equipment, and sand splashed or carried by vehicles. Estimate an appropriate value in the range of 0.8 (high losses from known sources such as snow blowers) to 1.2 (high accumulation from known sources). Use a factor of 1.0 for no miscellaneous losses/accumulations.

E: This reduction factor is provided to account for traction sand that passes through the sand trap without settling out. Because of particle size limitations, settling inefficiencies, and other factors, it may not be realistic or practicable to recover all of the traction sand that reaches the sand trap. Until empirical information is obtained from pilot studies, a value of 1.0 should be used for this factor.

F: This is the number of times the sand trap will be cleaned each season. Usually, the value for F is 1 as most basins are cleaned once per year, usually in the summer. If obtaining the required storage volume is difficult, it may be possible to implement mid-season cleaning (F greater than 1), but District maintenance staff should be consulted to make sure this is practicable. Mid-season cleaning requirements will also likely affect trap design, as maintenance equipment will have to access the trap under wet or snowy conditions.

Traction Sand Inlet Trap Design.

Conceptual traction sand trap devices are shown in Figures 1 – 3. Typical modifications from a standard Caltrans inlet include increasing the depth of the inlet so that there is a settling/storage area below the invert of the outlet pipe, linking multiple inlets at one location for increased sand storage volume, and adding weep holes to the bottom to allow the storage area to drain. The primary

design considerations for modifying a standard inlet into a traction sand trap device are sand storage volume, inlet depth, inlet drainage, and maintenance access.

Inlet Depth: Once the required storage volume has been determined, divide the required volume by the inlet's cross sectional area (plan view) to calculate the required depth of the inlet's traction sand storage area. The storage area should start at least 0.3 m below the invert of the inlet's outlet pipe and extend no more than 3 m below the inlet grate (or road surface). If the inlet is any deeper than that, a vacuum truck will have difficulty removing the traction sand from the bottom of the basin. Additionally, the bottom of the inlet should be at least a few meters above the ground water table. If the required storage volume cannot be met under these criteria, consider using double inlets or non-standard inlets, adding more inlets, using a different treatment control, or supplementing the traction sand inlets with additional down-stream controls.

Inlet Drainage: Because the bottom of a traction sand inlet is below the inlet's outlet pipe, additional drainage holes must be provided to prevent standing water and associated problems (e.g., mosquito breeding). The design infiltration rate should be limited to 50 percent of that indicated in the soils report. This would provide a factor of safety and allow for accumulation of fines that, over time, will reduce the infiltration rate. If the surrounding soils do not provide sufficient permeability to draw down the inlet within 48 hours, it may be necessary to select a different treatment control. Any traction sand inlet with drainage holes must be designed t prevent damage to the adjacent roadway subgrade. Typical mitigation measures include locating inlets only on the down-gradient side of the roadway, locating the top inlet drainage hole below the roadway subgrade, and providing additional drainage pathways (such as a leach line) to guide water away from the subgrade. Locating traction sand inlets on the high side of a super elevated section should be avoided.

Maintenance Access: Vacuum trucks are typically used to remove accumulated traction sand from the inlets. Providing a pullout area for the vacuum truck not only provides an additional measure of safety for the cleaning crew, but may also save time and money by avoiding land closures. At a minimum, the pullout area should be about 10 m long and about 3 m wide and be located so the inlet is near the front of the truck. (Also see "Inlet Depth," above.) See Standard Plans for maintenance vehicle pull out. Consult with District maintenance staff to see if inlet location markers are required.

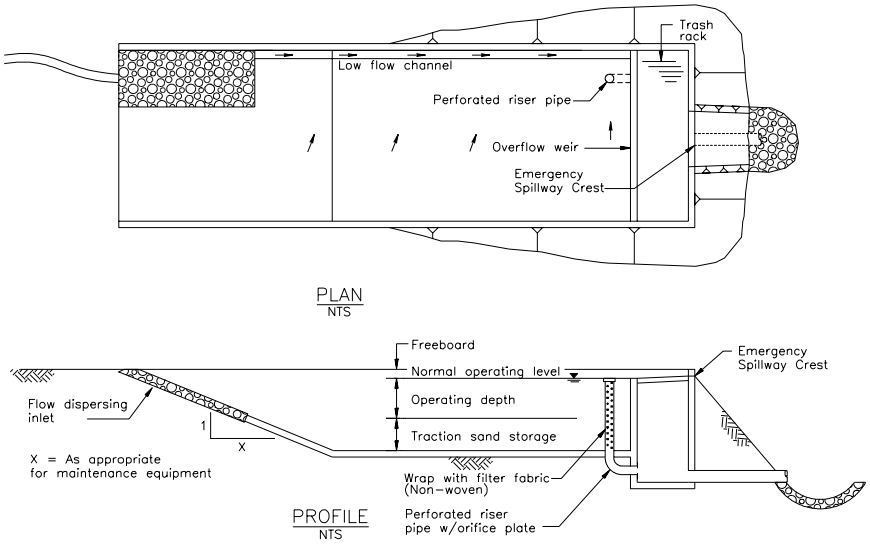


FIGURE 1

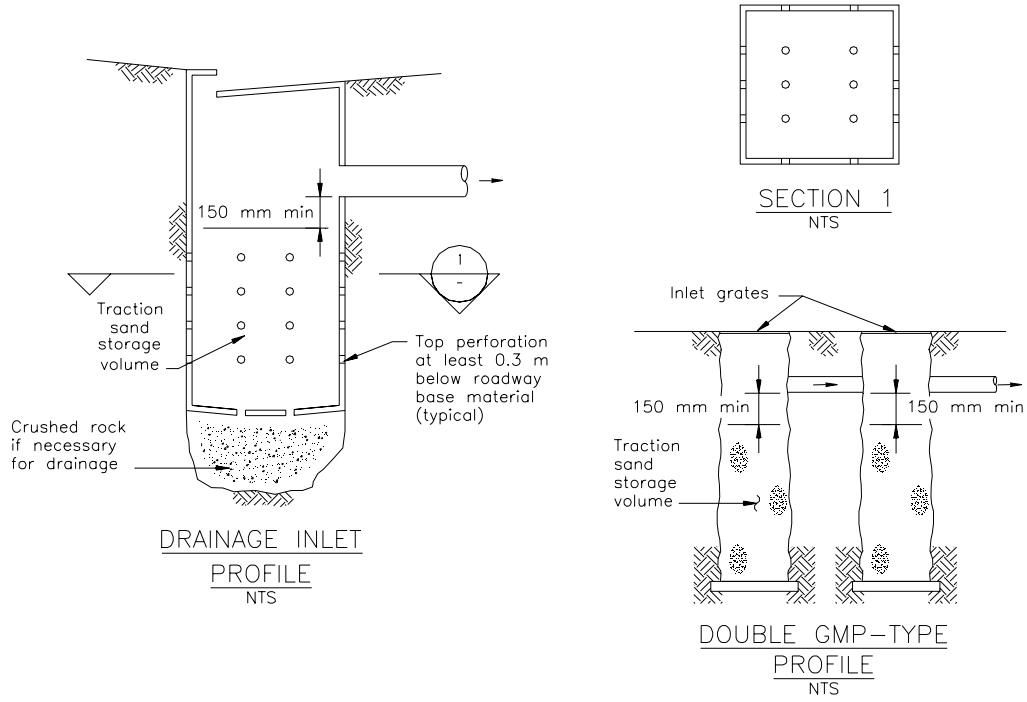


FIGURE 2

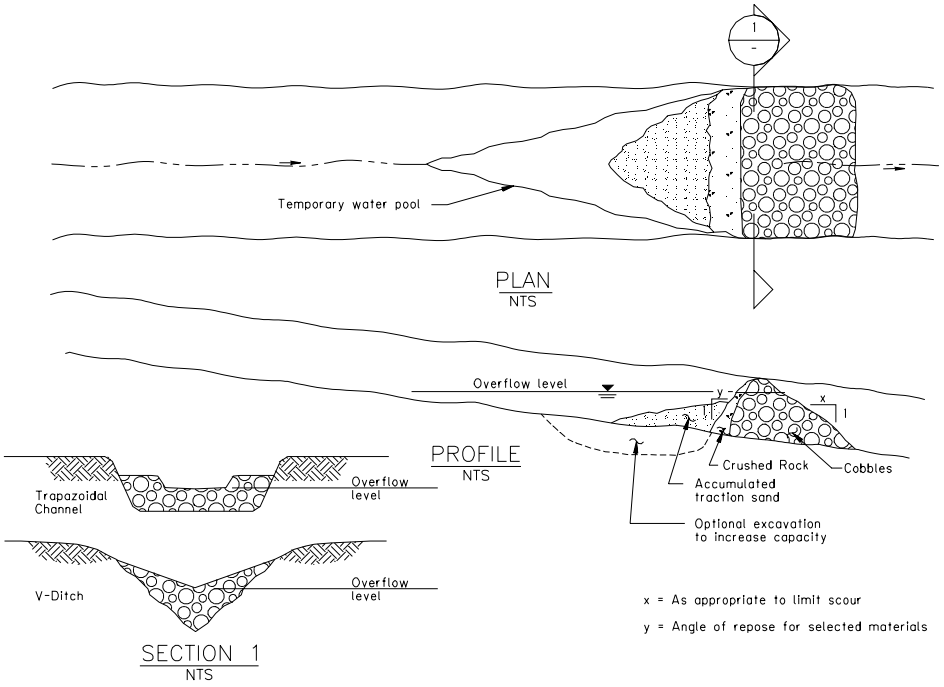

Temporary water pool
PLAN
NTS
Overflow level
y
x
1
1
PROFILE
NTS
Crushed Rock
Cobbles
Accumulated
traction sand
Optional excavation
to increase capacity
Trapazoidal
Channel
Overflow
level
V-Ditch
Overflow
level
x = As appropriate to limit scour
y = Angle of repose for selected materials
SECTION 1
NTS

FIGURE 3